# OROVILLE FERC RELICENSING
## (PROJECT NO. 2100)

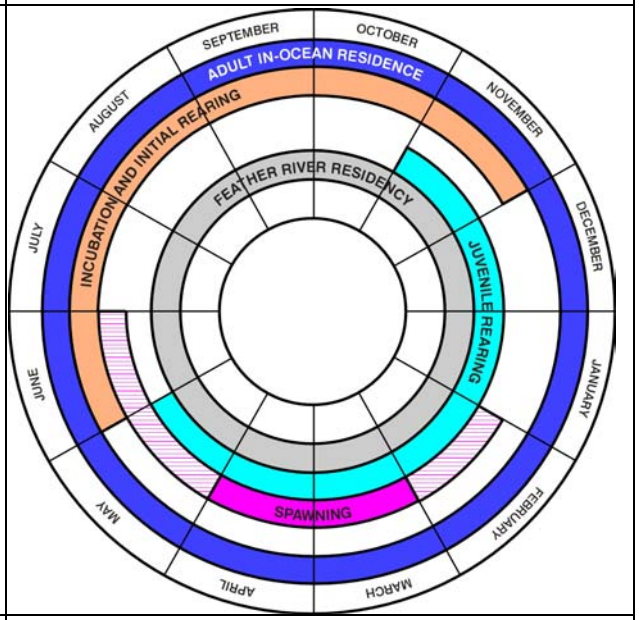
# INTERIM REPORT
# SP-F3.2 TASK 2
# SP-F21 TASK 1

## APPENDIX A
## MATRIX OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR FEATHER RIVER FISH SPECIES

## LITERATURE REVIEW OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR FEATHER RIVER FISH SPECIES

## WHITE STURGEON

**JANUARY 2003**

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| **General** | | | |
| common name (s) | English name (usually used by fishers and laypeople). | White Sturgeon | |
| scientific name (s) | Latin name (referenced in scientific publications). | *Acipenser transmontanus* | |
| taxonomy (family) | Common name of the family to which they belong. Also indicate scientific family name. | Sturgeon – *Acipenseridae* | |
| depiction | Illustration, drawing or photograph. |  |  |
| range | Broad geographic distribution, specifying California distribution, as available. | White sturgeon are restricted to Pacific coastal waters and river systems from Central California to Southern Alaska (Parsley et al. 1993).<br><br>White sturgeon live in rivers from central California to southern Alaska and migrate among them via the Pacific ocean (CRI Staff 2002). | In California, white sturgeon are most abundant in the San Francisco Bay estuary. This population spawns mainly in the Sacramento and Feather rvers (Moyle 2002). |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | | In a Columbia River study, white sturgeon moved throughout the Columbia River system, from the Columbia River estuary to its headwaters (Brannon et al. 1992).<br><br>White sturgeon are found in saltwater from Ensenada, Mexico, north to the Gulf of Alaska, but spawn only in large rivers from the Sacramento-San Joaquin river system northward. Landlocked populations exist in the Columbia River basin above major dams (Moyle 2002). | |
| native or introduced | If introduced, indicate timing, location, and methods. | Native. | |
| ESA listing status | Following the categories according to California Code of Regulations and the Federal Register, indicate whether: SE = State-listed Endangered; ST =State-listed Threatened; FE = Federally listed Endangered; FT = Federally-listed Threatened; SCE = State Candidate (Endangered); SCT = State candidate (Threatened); FPE = Federally proposed (Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed. | Not Listed. | |
| species status | If native, whether: Extinct/extirpated; Threatened or Endangered; Special concern; Watch list; Stable or increasing. If introduced, whether: Extirpated (failed introduction); highly localized; Localized; Widespread and stable; Widespread and expanding. | Native; the species is abundant or increasing in population size (Moyle 2002). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| economic or recreational value | Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both. | White sturgeon are an important recreational and commercial resource of the Pacific Northwest (Parsley et al. 1993).<br><br>White sturgeon support valuable commercial and sport fisheries in Canada, Oregon, and Washington. In California, they are taken in small numbers by the Native American fishery in the Klamath River, and support a major sport fishery in the San Francisco Bay estuary (Moyle 2002).<br><br>White sturgeon are considered an excellent food fish, and their eggs are marketed as caviar. Historically, air bladders of sturgeon were made into isinglass, a transparent, almost pure gelatin used as an adhesive and a clarifying agent (Fishbase 2002). | |
| warmwater or coldwater | Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids. | Coldwater. | |
| pelagic or littoral | Environment: Pelagic - living far from shore; Littoral - living near the shore. | White sturgeon generally spend most of their lives in the estuaries of large rivers, moving into freshwater to spawn, although a small numbers of sturgeon make extensive movements in the ocean. White sturgeon are most abundant in the brackish portions of estuaries, but also utilize deeper sections of estuaries. (Moyle 2002) | |
| bottom or water column distribution | Environment: bottom (benthic) or along water column. | Benthic. In estuaries, adult white sturgeon tend to concentrate in deep areas with soft substrates (Moyle 2002; Pacific States Marine Fisheries Commission 1996). | |
| lentic or lotic | Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like. | Low velocity basins (Brannon et al. 1992). | |
| **Adults** | | | |
| life span | Approximate maximum age obtained. | White sturgeon may live 100 years or more (CRI Staff 2002; Parsley et al. 1993), but sturgeon longer than 6.6 ft (2 m) and older than 27 years are rare (Moyle 2002). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| adult length | Indicate: Length at which they first reproduce; average length and maximum length the fish can attain. | White sturgeon can reach lengths of over 19.7 (6 m) (CRI Staff 2002; Parsley et al. 1993), (Moyle 2002).<br><br>Males are at least 10-12 years old and 29.5-41.3 inches (75-105 cm) FL before sexual maturity. Females do not mature until they are 12-16 years old and 37.4-53.1 inches (95-135 cm) FL (Moyle 2002).<br><br>Female sturgeon spawn at 15-20 years of age, and male sturgeon spawn at approximately 12 years of age (CRI Staff 2002).<br><br>In the San Francisco Bay estuary, young sturgeon reach 7.1-11.8 inches (18-30 cm) FL after the first year. By the 7$^{th}$ or 8$^{th}$ year, they reach 40.2 inches (102 cm) FL. In subsequent years, growth rates slow and sturgeon grow 0.79-2.4 inches (2-6 cm) in length per year (Moyle 2002). | |
| adult weight | Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain. | White sturgeon have been reported to weigh in excess of 1278.7 pounds (580 kg) (CRI Staff 2002; Parsley et al. 1993).<br><br>The largest authentic record weight for white sturgeon was of a specimen weighing 1388.9 (630 kg) (Moyle 2002).<br><br>In California, the most recent record is a female white sturgeon, 9.2 ft (2.8 m) TL, weighing 463 ponds (210 kg) (aged at 47 years). In 1963, CDFG recorded a dead male white sturgeon measuring 9.5 ft (2.9 m) TL, weighing 496 pounds (225 kg), in Shasta Reservoir (aged at least 67 years) (Moyle 2002). | |
| physical morphology | General shape of the fish: elongated, fusiform, laterally compressed, etc. | White sturgeon have long, cylindrical bodies with large heads and mouths (Pacific States Marine Fisheries Commission 1996). | |
| coloration | Indicate color, and color changes, if any, during reproduction phase. | The ventral body surface is white, shading to gray-brown on the back above the lateral scutes (Moyle 2002). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | | The dorsal color of white sturgeon is dark to light gray, pale olive, or gray-brown; its ventral color is white. The scutes of white sturgeon are lighter in color than the body, and fins are dusky to opaque gray (Pacific States Marine Fisheries Commission 1996). | |
| other physical adult descriptors | Unique physical features for easy identification. | The skeletons of white sturgeon are mainly comprised of cartilage. White sturgeon have thick skin and bony plates, called scutes instead of scales (CRI Staff 2002).<br><br>White sturgeon have four barbels located on the ventral side of the head (Pacific States Marine Fisheries Commission 1996). | |
| adult food base | Indicate primary diet components. | White sturgeon feed on bottom-dwelling invertebrates, including crabs, clams, and shrimp. Fish become increasingly important in the diets of larger sturgeon, especially herring, anchovy, striped bass, starry flounder, and smelt (Moyle 2002). | |
| adult feeding habits | Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. | White sturgeon are primarily benthic feeders (Moyle 2002). | |
| adult in-ocean residence time | For anadromous species, age when they migrate to the ocean and duration spent in the ocean before returning to freshwater to spawn. | | |
| adult habitat characteristics in-ocean | For anadromous species, description of the ocean habitat utilized: whether along major current systems, gyres, pelagic (beyond continental shelves) and neritic (above continental shelves) zones, etc. | | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| **Adult upstream migration (immigration)** | | | |
| range of adult upstream migration timing | Time of year adults migrate upstream. If applicable, indicate for various runs. | In California, adult white sturgeon move upstream when they are ready to spawn. Spawning occurs between late February and early June (during winter and spring months). Upstream movements are apparently triggered by increases in flow (Moyle 2002).<br><br>White sturgeon move upstream during the winter and spring months (Brannon et al. 1992). | |
| peak adult upstream migration timing | Time of year most adults migrate upstream. If applicable, indicate for various runs. | White sturgeon most commonly move into large rivers in the early spring (Pacific States Marine Fisheries Commission 1996). | |
| adult upstream migration water temperature tolerance | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | | |
| adult upstream migration water temperature preference | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental. | | |
| **Adult holding (freshwater residence)** | | | |
| water temperature tolerance for holding adults | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | | |
| water temperature preference for holding adults | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental. | | |
| water depth range for holding adults | Reported range of observed (minimum and maximum) water depth utilization. | Adult white sturgeon have been observed in waters 6.6-98.4 ft (2m-30m) in depth (Counihan et al. 1999).<br><br>In the Columbia River, adult white sturgeon were observed in shallow water less than 23 ft (7m) deep (Parsley et al. 1993). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| water depth preference for holding adults | Reported range of most frequently observed water depth utilization. | In the Columbia River system, adult white sturgeon were observed at a mean water depth of 36.1 (11m) (Counihan et al. 1999).<br><br>White sturgeon reside in shallow water during periods of high activity (summer) and in deep water during the winter (Brannon et al. 1992). | |
| substrate preference for holding adults | If bottom dwellers, indicate substrate: mud, sand, gravel, boulders, aquatic plant beds, etc. If gravel, indicate range or average size of gravel. | In Lake Roosevelt, sturgeon showed the highest residence time over very fine sediment (Brannon et al. 1992). | |
| water velocity range for holding adults | Reported range of observed (minimum and maximum) water velocity utilization. | In the Columbia River, adult white sturgeon exceeding 6.6 ft (2 m) can negotiate water velocities of 13.1-19.7 ft/s (4-6 m/s), or approximately two to three times their body length per second(Parsley et al. 1993).<br><br>In the Columbia River system, white sturgeon are found in water velocities of 0.3-6.6 ft/s (0.1-2.0 m/s) (Counihan et al. 1999). | |
| water velocity preference for holding adults | Reported range of most frequently observed water velocity utilization. | In the Columbia River system, the average water velocity utilized by white sturgeon is 2 ft/s (0.6 m/s) (Counihan et al. 1999). | |
| other habitat characteristics for holding adults | General description of habitat (e.g. turbid or clear waters, lentic or lotic, presence of aquatic plant beds, debris, cover, etc.). | In the Columbia River system, white sturgeon utilized deep holes (Brannon et al. 1992).<br><br>Adult white sturgeon utilized the interface between the Lake Roosevelt impoundment and the Columbia River (Brannon et al. 1992). | |
| timing range for adult holding | Time of year (earliest-latest) and duration of stay from upstream migration to spawning. | | |
| timing peak for adult holding | Time of year when maximum number of adults are present before spawning. | | |
| **Spawning** | | | |
| fecundity | Average or range in the number of eggs females lay in a | Female white sturgeon can produce 300,000-4,000,000 eggs (CRI Staff 2002; Wang 1986). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | spawning season. | Female white sturgeon can produce from 100,000 to several million eggs (Pacific States Marine Fisheries Commission 1996).<br><br>In the Sacramento River, fecundity averages 2,555 eggs per lb (5,648 eggs per kg) of body weight. A typical female [4.9 ft (1.5 m ) FL] contains 200,000 eggs (Moyle 2002). | |
| nest construction | Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc. | No nest is built (Pacific States Marine Fisheries Commission 1996). | |
| nest size | Size and average dimensions of the nest. | N/A | |
| spawning process | Indicate whether nest builder, broadcast spawner, or other. | White sturgeon are broadcast spawners (Pacific States Marine Fisheries Commission 1996). | |
| spawning substrate size/characteristics | Range of substrates used during spawning (e.g. mud, sand, gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size. | In the Columbia River, most eggs were observed over cobble and boulder substrates, although some eggs were also observed over sand, gravel and bedrock (Parsley et al. 1993).<br><br>Generally, spawning occurs over deep gravel riffles or in deep holes with swift currents over rock bottoms (Moyle 2002). | |
| preferred spawning substrate | Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc). | In the Columbia River, white sturgeon spawn over cobble in impoundments and over boulders in the lower river (Parsley et al. 1993).<br><br>In spawning areas of the Sacramento River, white sturgeon utilize gravel substrates (Moyle 2002).<br><br>White sturgeon spawn over rocky substrates (Pacific States Marine Fisheries Commission 1996). | |
| water temperature tolerance for spawning | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| water temperature preference for spawning | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | Suitable water temperatures for white sturgeon spawning in California are 46.4°F-66.2°F (8°C-19°C); peak spawning occurs at water temperatures of approximately 57.2°F (14°C) (Moyle 2002).<br><br>In the lower Columbia River, spawning was observed in water temperatures of 50°F-64.4°F (10°C-18ºC). In the impoundments of the Columbia River, spawning was observed in water temperatures of 53.6°F-64.4°F (12°C-18ºC). Most spawning occurs in water temperatures of approximately 57.2°F (14°C) in the river and associated impoundments (Parsley et al. 1993).<br><br>In the Sacramento River, white sturgeon spawning occurred in water temperatures of 46°F-64°F (7.8°C-17.8ºC). Maximum spawning occurred at approximately 58°F (14.4 °C) (Kohlhorst 1976).<br><br>Suitable water temperatures for white sturgeon spawning are 53.6°F-59°F (12°C-15ºC) (Wang 1986).<br><br>The reported optimal water temperature for white sturgeon spawning is 55.9°F (13.3ºC) (Gadomski et al. 2002). | |
| water velocity range for spawning | Minimum and maximum speed of water current the spawning fish can tolerate. | In the lower Columbia River, white sturgeon spawning was observed at water column velocities of 3.3-9.2 ft/s (1.0–2.8 m/s) and velocities near the substrate of 2-7.9 ft/s (0.60–2.40 m/s) (Parsley et al. 1993).<br><br>In impoundments of the Columbia River, spawning was observed at water column velocities of 2.7-6.9 ft/s (0.81–2.1m/s) and velocities near the substrate of 1.7-5.3 ft/s (0.52–1.62 m/s) (Parsley et al. 1993).<br><br>In the Columbia River, spawning occurs at water velocities of 2-7.9 ft/s (0.6-2.4m/s) (Moyle 2002).<br><br>In the Sacramento River, there was no obvious flow threshold at which spawning occurred (Kohlhorst 1976). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | | White sturgeon are known to spawn in swift currents, near rapids (Pacific States Marine Fisheries Commission 1996). | |
| water velocity preference for spawning | Preferred water current (flow velocity) during spawning. | In the lower Columbia River, most spawning was observed at a water column velocity of 6.9 ft/s (2.1 m/s) and a velocity near the substrate of 4.6 ft/s (1.4 m/s) (Parsley et al. 1993).<br><br>In impoundments of the Columbia River, most spawning was observed at water column velocity of 4.8 ft/s (1.46 m/s) and a velocity near the substrate of 3.4 ft/s (1.04 m/s) (Parsley et al. 1993). | |
| water depth range for spawning | Reported range of observed (minimum and maximum) water depth utilization. | In the lower Columbia River, spawning was observed at depths of 13.1-75.5 ft (4–23 m) (Parsley et al. 1993).<br><br>In impoundments of the Columbia River, spawning was observed at depths of 13.1-78.7 ft (4–24 m) (Parsley et al. 1993).<br><br>In the lower Sacramento River eggs were collected at a depth of 32.8 ft (10 m) (Wang 1986). | |
| water depth preference for spawning | Reported range of most frequently observed water depth utilization. | In the lower Columbia River, most spawning was observed at depths of 19.7 ft (6 m) (Parsley et al. 1993).<br><br>In impoundments of the Columbia River, most spawning was observed at depths of 36.1 ft (11 m) (Parsley et al. 1993). | |
| range for spawning timing | Earliest and latest time of season or year in which spawning occurs. | In the Columbia River, white sturgeon spawning coincides with peak flows during spring and early summer (Parsley et al. 1993).<br><br>Conditions favorable for white sturgeon spawning in the Columbia River occurred from April through July (Counihan et al. 1999).<br><br>White sturgeon spawning in the Columbia River system occurs from April through July (Parsley et al. 1993). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | | In the Sacramento River, white sturgeon spawning occurs from mid-February to late May (Kohlhorst 1976).<br><br>Sturgeon spawner aggregations in Lake Roosevelt occurred from early spring to mid-summer (Brannon et al. 1992).<br><br>In California, white sturgeon spawning occurs between late February and early June (Moyle 2002).<br><br>In the Sacramento River, white sturgeon eggs were collected in April and May (Wang 1986). | |
| peak spawning timing | Time of year most fish start to spawn. | In the Sacramento River, spawning was most intense during March and April (Kohlhorst 1976).<br><br>In the Columbia River system, reported optimal spawning conditions occurred in mid-May (Gadomski et al. 2002)<br><br>White sturgeon most commonly spawn from May through June (Pacific States Marine Fisheries Commission 1996). | |
| spawning frequency (iteroparous/semelparous) | Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction.<br>Iteroparous - producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes. | Male white sturgeon spawn every 1-2 years, but females wait 2-4 years between spawns (Moyle 2002).<br><br>White sturgeon spawn every 4-11 years (Pacific States Marine Fisheries Commission 1996). | |
| **Incubation/early development** | | | |
| egg characteristics | Shape, size, color, in clusters or individuals, stickiness, and other physical attributes. | White sturgeon eggs are adhesive and stick to the substrate (Moyle 2002).<br><br>White sturgeon eggs are spherical, oval or slightly irregular, slate gray in color, whitish in color at the pole, and 0.1-0.2 inches (3.3 mm-4.0 mm) in diameter (Wang 1986). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| water temperature tolerance for incubation | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | Elevated mortality occurred among developing white sturgeon embryos incubated at 64.4°F (18ºC), and complete mortality occurred in embryos incubated at 68°F (20ºC). (Parsley et al. 1993). | |
| water temperature preference for incubation | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | The median water temperature at which spawning occurred in the Columbia River [i.e., 57.2°F (14°C)] is reported as the optimal water temperature for white sturgeon egg development (Parsley et al. 1993). | |
| time required for incubation | Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent. | Larvae hatch in 4-12 days, depending on water temperature. Eggs hatch in a little more than 4 days at 60.8°F (16ºC) or in 8-12 days at 53.6°F (12ºC) (Wang 1986).<br><br>Eggs can hatch in 4 days to 2 weeks depending on water temperature (Pacific States Marine Fisheries Commission 1996). | |
| size of newly hatched larvae | Average size of newly hatched larvae. | White sturgeon larvae are 0.3-0.8 inches (7.5 and 19.5 mm) in length (Kohlhorst 1976).<br><br>In Sacramento-San Joaquin river, newly hatched larvae measure 0.4 inches (11.0 mm) in length (Wang 1986). | |
| time newly hatched larvae remain in gravel | Time of year of hatching, and duration between hatching and emergence from gravel. | White sturgeon larvae remain in gravel for 7-10 days (Moyle 2002)<br><br>Under laboratory conditions, larvae hatch in approximately 12 days (Parsley et al. 1993). | |
| other characteristics of larvae | Alevin -- early life history phase just after hatching (larva) when yolk-sac still present. | In a laboratory experiment, newly hatched larvae swam towards the surface and remained in the water column for a length of time that was inversely related to water velocity. The larvae then sought cover in or on the substrate and appeared to be photophobic. This “hiding” phase lasted until the yolk was absorbed (approximately 12 days after hatch) (Parsley et al. 1993).<br><br>Larvae are initially pelagic; becoming demersal when pectoral fins are fully developed (Wang 1986).<br><br>When yolk sacs are still present, the larvae swim vertically and drift downstream towards the estuary. | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| | | The yolk sac is absorbed in 7-10 days, and the larvae begin actively feeding from the bottom (Wang 1986). | |
| timing range for emergence | Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites. | Larvae emerge from gravel from June through November (Parsley et al. 1993). | |
| timing peak for emergence | Time of year most hatchlings emerge. | | |
| size at emergence from gravel | Average size of hatchlings at time of emergence. | | |
| **Juvenile rearing** | | | |
| general rearing habitat and strategies | General description of freshwater environment and rearing behavior. | | |
| water temperature tolerance for juvenile rearing | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | | |
| water temperature preference for juvenile rearing | Range of suitable, preferred, or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | 64.4°F (18ºC) is identified as the preferred water temperature for rearing white sturgeon (Moyle 2002). | |
| water velocity ranges for rearing juveniles | Reported range of observed (minimum and maximum) water velocity utilization. | Juvenile white sturgeon in the Columbia River system (including impoundments) were collected in water column velocities and near-substrate velocities of 0.3-3.9 ft/s (0.1-1.2) and 0.2-2.6 ft/s (0.06-0.8 m/s), respectively (Parsley et al. 1993). | |
| water velocities preferred by rearing juveniles | Reported range of most frequently observed water velocity utilization. | Juvenile white sturgeon in the Columbia River system (including impoundments) were collected in median water column velocities and near-substrate velocities of 2.0-2.1 ft/s (0.61-0.65 m/s) and 1.2-2.0 ft/s (0.37-0.6 m/s), respectively (Parsley et al. 1993). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| water depth range for juvenile rearing | Reported range of observed (minimum and maximum) water depth utilization. | Juvenile white sturgeon in the Columbia River system (including impoundments) were collected in water depths of 6.6-190 feet (2-58 m) (Parsley et al. 1993). | |
| water depth preference for juvenile rearing | Reported range of most frequently observed water depth utilization. | Juvenile white sturgeon in the Columbia River system (including impoundments) were collected in median water depths of 52.5-62.3 feet (16-19 m) (Parsley et al. 1993).<br><br>Juvenile white sturgeon were most often captured within the thalweg (deepest part of the river or stream channel) (Parsley et al. 1993). | |
| cover preferences for rearing juveniles | Type of cover for protection from predators used by rearing juveniles (e.g. crevices, submerged aquatic vegetation, overhanging vegetation, substrate cover, undercover bank, small woody debris, large woody debris). | | |
| food base of juveniles | Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs. | Young white sturgeon feed mostly on crustaceans, and as they grow their diet becomes more varied (Moyle 2002).<br><br>Small white sturgeon feed mainly on chironomids, but also take small crustaceans, other insects, and mollusks (Fishbase 2002).<br><br>Young white sturgeon primarily feed on algae and aquatic insects (Pacific States Marine Fisheries Commission 1996).<br><br>Juvenile white sturgeon feed on mysid shrimp, amphipods, small clams, polychaetes, and fish eggs (Wang 1986). | |
| feeding habits of rearing juveniles | Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. Also indicate change of feeding habits growth occurs. | Juvenile feeding is concentrated during the night (Wang 1986). | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| predation of juveniles | Indicate which species prey on juveniles. | Channel catfish, northern pikeminnow, and prickly sculpin are predators of white sturgeon (Gadomski et al. 2002). | |
| timing range for juvenile rearing | Range of time of year (months) during which rearing occurs. | | |
| timing peak for juvenile rearing | Time of year (months) during which most rearing occurs. | | |
| **Juvenile emigration** | | | |
| time spent in fresh water prior to emigrating | Duration (in years and/or months) from emergence to emigration to the ocean. | | |
| water temperature tolerances during emigration | Range of water temperatures allowing survival. Indicate stressful or lethal levels. | | |
| water temperature preferences during emigration | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | | |
| emigration timing range | Time of year juveniles commence emigration and duration of emigration. | | |
| emigration timing peak | Time of year most juveniles are emigrating. | | |
| size range of juveniles during emigration | Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size. | | |
| **Other potential factors** | | | |
| DO | Levels of dissolved oxygen in water expressed in mg/l tolerated by fish. | | |
| pH | Alkalinity/acidity of water (expressed in pH) that fish can tolerate. | | |

| Element | Element Descriptor | General | Feather River specific |
|---|---|---|---|
| turbidity | Indicate turbidity or state of water (e.g., clear water or presence of siltation or organic/inorganic matter in water) that fish can tolerate. | | |
| factors contributing to mortality | e.g. fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc. | In the San Francisco Bay estuary, spawning success varies from year to year such that the white sturgeon population tends to be dominated by a few strong year classes. Large year classes are associated with high outflows through the San Francisco Bay estuary in spring. This relationship may result from larval sturgeon being moved quickly downstream to suitable rearing areas, where food is abundant and the probability of entrainment is low. Higher river flows also may stimulate larger numbers of sturgeon to spawn (Moyle 2002).<br><br>In the Columbia River system, factors associated with the decline of white sturgeon populations include over-fishing and hydropower facility installation, which results in habitat alterations (Gadomski et al. 2002).<br><br>Because of its long life span, white sturgeon tend to concentrate pollutants in their flesh. Bioaccumulation of PCBs and other contaminants inhibit sturgeon growth and decrease egg and larval survival (Pacific States Marine Fisheries Commission 1996).<br><br>Dams negatively impact white sturgeon by creating landlocked populations and destroying spawning grounds by altering water flow (Pacific States Marine Fisheries Commission 1996). | |

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